

What is claimed is:

1. A constant temperature distilling process,  
comprising the steps of implementing a  
5 drain-to-vacuum process using a degassed liquid  
to set a constant temperature distillation unit  
for vacuum distillation, or a constant temperature  
distillation unit for vacuum cooling to an initial  
state thereof; and setting a vacuum distilling  
10 temperature for said constant temperature  
distillation unit for a degassed solution therein  
to boil and evaporate at said set vacuum distilling  
temperature in said unit; such that an equilibrium  
thermal cycling between evaporation and  
15 condensation can be maintained throughout said  
constant temperature distillation unit, and  
evaporation heat and condensate produced in said  
constant temperature distilling process are  
recovered and collected, respectively.  
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2. The constant temperature distilling process as  
claimed in claim 1, wherein said constant  
temperature distillation unit for vacuum cooling  
includes an evaporating vessel, into which  
25 constant-temperature degassed solution flows via

corresponding conduits and control valves at a predetermined flow rate, said evaporating vessel being connected to a condenser via a condensing tube for vapors produced by said evaporating vessel to flow into said condenser; a flow regulating valve provided on said condensing tube at a predetermined position for controlling the flow rate of vapors discharged from said evaporating vessel when said evaporating vessel is under a saturated vapor pressure at said set vacuum distilling temperature, and thereby maintaining said evaporating vessel at said desired saturated vapor pressure; a condenser, into and out of which hot circulating solution flows via corresponding conduits and control valves at a predetermined flow rate to absorb evaporation heat of vapors produced by said evaporating vessel and flow into said condenser, so that said hot circulating solution is heated to a higher temperature and said vapors are condensed into liquid, which is then discharged into and collected with a vacuum vessel; and a lower vessel and parts thereof being located below said evaporating vessel with a predetermined height difference existed between them for producing vacuums in said conduits, said evaporating vessel,

and said condenser through which said degassed solution, said vapors, or said condensed liquid flows.

5     3. The constant temperature distilling process as claimed in claim 1, wherein said constant temperature distillation unit for vacuum distillation includes an evaporating vessel; and a liquid-gas interface provided in said evaporating vessel, into and out of which a hot circulating solution flows via corresponding conduits and control valves at a predetermined flow rate, and said hot circulating solution providing evaporation heat through a heat transfer at said liquid-gas interface to evaporate said degassed solution in said evaporating vessel.

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4. The constant temperature distilling process as claimed in claims 2 and 3, further comprising the step of vacuumizing said conduits, said evaporating vessel, and said condenser, through which said degassed solution, said vapors, or said condensed liquid flows, through implementing said drain-to-vacuum process using said degassed liquid to set said constant temperature distillation unit

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for vacuum distillation to an initial state;  
sealing said conduits, said evaporating vessel,  
and said condenser; closing said flow regulating  
valve; filling said vacuumized evaporating vessel  
5 with said degassed solution to a predetermined  
liquid level; and finally, setting the vacuum  
distilling temperature for said evaporating vessel;  
wherein said vacuum distilling temperature being  
lower than temperatures of said degassed solution  
10 and said hot circulating solution flown into said  
evaporating vessel and said liquid-gas interface,  
respectively.

5. The constant temperature distilling process as  
15 claimed in claim 4, further comprising the steps  
of causing said degassed solution and said hot  
circulating solution to continuously flow into and  
out of said evaporating vessel and said liquid-gas  
interface, respectively, for said evaporating  
20 vessel to continuously produce vapors; opening said  
flow regulating valve when said evaporating vessel  
reaches said saturated vapor pressure at said  
vacuum distilling temperature, in order to allow  
said vapors produced by said evaporating vessel  
25 to flow into said condenser and thereby maintaining

said evaporating vessel at a stable saturated vapor pressure; and regulating said flow regulating valve to decrease a flow rate of said vapors being discharged when said degassed solution or said hot circulating solution providing evaporation heat has a flow-out temperature lower than said vacuum distilling temperature, or regulating said flow regulating valve to increase a flow rate of said vapors being discharged when said degassed solution or said hot circulating solution providing evaporation heat has a flow-out temperature higher than said vacuum distilling temperature.

6. The constant temperature distilling process as claimed in claim 5, wherein said equilibrium thermal cycling between evaporation and condensation is obtained by keeping said hot circulating solution providing evaporation heat at a temperature higher than that of said hot circulating solution recovering evaporation heat, so that said evaporating vessel has a working temperature higher than that of said condenser.

7. The constant temperature distilling process as claimed in claim 4, wherein said drain-to-vacuum

process is implemented only to partially vacuumize said evaporating vessel when said degassed liquid used in said drain-to-vacuum process is the same as said degassed solution.

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8. The constant temperature distilling process as claimed in claim 5, further comprising the step of implementing said drain-to-vacuum process using said degassed solution for a second time to set  
10 said constant temperature distillation unit for vacuum distillation or vacuum cooling to the initial state and thereby resume said unit to a desired degree of vacuum when air remained in said degassed solution continuously accumulates in said  
15 conduits, said evaporating vessel, and said condenser, through which said degassed solution, said vapors, or said condensed liquid flows, to produce a pressure high enough to affect said vacuum distilling temperature set for said degassed  
20 solution.

9. A multi-stage vacuum distilling process for solution separation, comprising the steps of providing a tower-like multi-stage vacuum  
25 distilling system; setting said multi-stage vacuum

distilling system to an initial state thereof;  
performing a constant temperature distilling  
process, transferring of solutions, and recycling  
of a hot circulating solution to separate said  
5 solution and recover most part of heat energy for  
use repeatedly; and setting a vacuum distilling  
temperature for each stage of said multi-stage  
vacuum distilling system according to a temperature  
gradient of said hot circulating solution, so that  
10 said solution separation is achieved in the form  
of multi-stage vacuum distillation; wherein both  
said vacuum distilling temperature and a saturated  
vapor pressure corresponding thereto decrease from  
upper to lower stages in said multi-stage vacuum  
15 distilling system, allowing expanded ranges of  
usable vacuum distilling temperature and pressure  
as well as an increased number of vacuum distilling  
stages and more of said solution separable with  
one unit of energy.

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10. The multi-stage vacuum distilling process for  
solution separation as claimed in claim 9, wherein  
said multi-stage vacuum distilling system includes  
fore-treatment equipment including heaters  
25 separately for heating a degassed solution and said

hot circulating solution to a set temperature; a plurality of constant temperature distillation units for vacuum distillation sequentially stacked one by one into a tower-like structure, in which  
5 a first stage, or the highest stage, is stacked over a second stage, the second stage is stacked over a third stage, etc., and in-flow conduits of one said constant temperature distillation unit at a lower stage are connected at a distal end to  
10 corresponding out-flow conduits of one said constant temperature distillation unit at an upper stage; and post-treatment equipment including vacuum vessels separately for collecting condensate and concentrated solution, a first heat  
15 exchanger for lowering a temperature of said hot circulating solution discharged at the last stage, a second heat exchanger for keeping said vacuum vessel for collecting said condensate at a set temperature, a common lower vessel and parts  
20 thereof for producing vacuums in said constant temperature distillation units for vacuum distillation, and a circulation pump for said hot circulating solution.

25 11. The multi-stage vacuum distilling process for



solution separation as claimed in claim 10, wherein  
said step of setting said multi-stage vacuum  
distilling system to an initial state thereof is  
performed by sequentially setting said constant  
5 temperature distillation units for vacuum  
distillation to their initial state one by one from  
lower to upper stages; and wherein in said step  
of setting a vacuum distilling temperature for each  
stage of said multi-stage vacuum distilling system  
10 according to a temperature gradient of said hot  
circulating solution, said temperatures set for  
said multiple stages of said vacuum distilling  
system decrease from upper to lower stages, so that  
a saturated vapor pressure at the temperature set  
15 for each vacuum distillation stage decreases from  
upper to lower stages.

12. The multi-stage vacuum distilling process for  
solution separation as claimed in claim 10, wherein  
20 said step of transferring solutions further  
includes the steps of causing said degassed  
solution heated to a set temperature to  
continuously flow into said evaporating vessel at  
each stage from upper to lower stages at a  
25 predetermined flow rate; allowing said degassed

solution to evaporate at each stage, so that said degassed solution has a concentration gradually increases from upper to lower stages or forms crystalline precipitate therein; collecting said concentrated solution discharged at the last stage with said vacuum vessel; subjecting said collected concentrated solution to further solute concentration using vacuum freezing and drying; filtering off any crystalline precipitate before said degassed solution flows into said evaporating vessel at the next lower stage, if there is crystalline precipitate in said evaporating vessel; and collecting said crystalline with a vacuum vessel.

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13. The multi-stage vacuum distilling process for solution separation as claimed in claim 10, wherein said step of recycling a hot circulating solution further includes the steps of causing said hot circulating solution heated to a set temperature to continuously flow into and out of a liquid-gas interface at each stage from upper to lower stages at a constant flow rate to provide said degassed solution with required evaporation heat, so that the temperature of said hot circulating solution

decreases from upper to lower stages; using said first heat exchanger to lower the temperature of said hot circulating solution discharged at the last stage; and using said circulation pump to cause  
5 said hot circulating solution to continuously flow into and out of a condenser at each stage from lower to upper stages to absorb evaporation heat and thereby condense produced vapors to condensate, so that the temperature of said hot circulating  
10 solution increases from lower to upper stages; and allowing said hot circulating solution to flow back to said heater for heating said circulating solution.

15 14. The multi-stage vacuum distilling process for solution separation as claimed in claim 9, wherein said temperature gradient of said hot circulating solution is set according to a liquid-gas equilibrium curve of said degassed solution and  
20 then used to set the vacuum distilling temperature at each stage of vacuum distillation, enabling the forming of non-overlapped temperature ranges for different stages, and a trapezoidal temperature curve showing said temperature gradient of said  
25 hot circulating solution flowing through each

vacuum distilling stage.

15. A multi-stage vacuum cooling and freezing process for solution separation, which utilizes freezing and melting to produce condensate and may be used to assist in multi-stage vacuum distillation to increase the number of stages thereof, comprising the steps of providing and combining a tower-like multi-stage vacuum cooling system and a tower-like multi-stage vacuum freezing system; setting said multi-stage cooling and freezing systems to an initial state thereof; and performing transferring of solutions, a constant temperature distilling process, and a drain-to-vacuum and freezing process to produce ice crystals in a degassed solution; wherein said multi-stage vacuum freezing system using a low-temperature solution discharged at the lowest stage of said multi-stage vacuum cooling system as an initial solution needed to perform said multi-stage vacuum freezing to save energy needed for pre-cooling, and using vapors produced in multi-stage vacuum distilling and cooling processes as condensation heat required to melt said ice crystals produced in said degassed solution; low-temperature concentrated solution

and molten ice crystals produced through said multi-stage vacuum freezing process being used to cool a hot circulating solution discharged from the last stage of multi-stage vacuum distillation and to maintain the temperature of a vacuum vessel for collecting the condensate produced in said multi-stage vacuum distillation, enabling an expanded distilling temperature range and accordingly increased stages for the multi-stage distillation and increased yield of solution separable with one unit of energy.

16. The multi-stage vacuum cooling and freezing process for solution separation as claimed in claim 15, wherein said multi-stage vacuum cooling system includes a plurality of constant temperature distillation units for vacuum cooling sequentially stacked one by one into a tower-like structure, in which a first stage, or the highest stage, is stacked over a second stage, the second stage is stacked over a third stage, etc., with in-flow conduits of one said constant temperature distillation unit for vacuum cooling at a lower stage connected at a distal end to corresponding out-flow conduits of one said constant temperature

distillation unit for vacuum cooling at an upper stage; and a common lower vessel and parts thereof for said a plurality of constant temperature distillation units for vacuum cooling.

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17. The multi-stage vacuum cooling and freezing process for solution separation as claimed in claim 16, wherein said multi-stage vacuum freezing system includes a plurality of freezing vessels sequentially stacked one by one into a tower-like structure, in which a first stage, or the highest stage, is stacked over a second stage, the second stage is stacked over a third stage, etc.; a liquid-solid interface provided in each of said freezing vessels for heat transfer; a condenser that enables releasing of condensation heat and evaporation heat from said degassed solution; a plurality of conduits and control valves thereof connecting said multi-stage vacuum freezing system to said multi-stage vacuum distillation system and said multi-stage vacuum cooling system to allow vapors produced through multi-stage vacuum distillation and multi-stage vacuum cooling to separately flow into said freezing vessel at each stage; a plurality of conduits and control valves

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thereof cooperating with said lower vessel and parts thereof provided for said multi-stage vacuum cooling system to produce vacuums in said conduits and said freezing vessels through which said degassed solution, said produced vapors, or said condensate flow; and vacuum vessels separately for collecting molten ice crystals and low-temperature concentrated solution produced in said multi-stage vacuum freezing process.

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18. The multi-stage vacuum cooling and freezing process for solution separation as claimed in claim 17, wherein said step of setting said multi-stage vacuum cooling system to an initial state thereof is performed by sequentially setting said constant temperature distillation units for vacuum cooling to their initial state one by one from lower to upper stages, and then setting a temperature of vacuum cooling for each stage of said multi-stage vacuum cooling system; and said temperatures set for said multiple stages of said vacuum cooling system decrease from upper to lower stages, so that a saturated vapor pressure at the temperature set for each vacuum cooling stage decreases from upper to lower stages.

19. The multi-stage vacuum cooling and freezing process  
for solution separation as claimed in claim 17,  
wherein said step of setting said multi-stage  
5 vacuum freezing system to an initial state thereof  
is performed by implementing the drain-to-vacuum  
process using a degassed liquid for all stages one  
by one from bottom to top to vacuumize said freezing  
vessels and said conduits through which said  
10 degassed solution, said vapors, or said condensate  
flow, and then seal said freezing vessels and said  
conduits.

20. The multi-stage vacuum cooling and freezing process  
15 for solution separation as claimed in claim 17,  
wherein said step of transferring solutions further  
includes the steps of fully filling said freezing  
vessel at the first stage with said low-temperature  
solution discharged at the last stage of said  
20 multi-stage vacuum cooling system; implementing  
the drain-to-vacuum and freezing process to produce  
ice crystals in said freezing vessel at the first  
stage of said multi-stage vacuum freezing system;  
causing each of said freezing vessels at a higher  
25 stage to completely discharge all said degassed



solution that has not yet frozen into ice crystals to said freezing vessel at the next lower stage or said vacuum vessel; guiding said vapors produced in said multi-stage vacuum distilling and cooling processes to said freezing vessel at the first stage of said multi-stage vacuum freezing system to melt said ice crystals produced in said freezing vessel; collecting said molten ice crystals with said vacuum vessel for molten ice crystals; implementing the drain-to-vacuum and freezing process in said freezing vessel at the next lower stage of said multi-stage vacuum freezing system or collecting said low-temperature concentrated solution with said vacuum vessel for low-temperature concentrated solution; and filtering off crystalline precipitate, if any, in said freezing vessel at an upper stage before said degassed solution flows into said freezing vessel at a lower stage; and collecting said crystalline with a vacuum vessel.

21. The multi-stage vacuum cooling and freezing process for solution separation as claimed in claim 17, wherein said drain-to-vacuum and freezing process further includes the steps of filling said

vacuumized freezing vessel having said liquid-solid interface provided therein with a predetermined amount of a low-temperature solution; implementing the drain-to-vacuum process to discharge said low-temperature solution at a predetermined speed to said vacuumized freezing vessel at the next lower stage or to said vacuum vessel; and using said condenser to continuously release said condensation heat and said evaporation heat in said freezing vessels for said solution in said freezing vessels to freeze into ice crystals on surfaces of said liquid-solid interfaces; said ice crystals forming at an increased speed when a vacuum volume in each of said freezing vessels increases, and ice crystals having even composition being finally formed on said liquid-solid interfaces in said freezing vessels.